EVALUATION OF ARC OF CLOSURE USING ARBITRARY EAR PIECE FACE BOW AND SEMI- ADJUSTABLE ARTICULATOR AN INVIVO STUDY

A Dissertation Submitted

to the Tamil Nadu Dr. M.G.R. Medical University
In partial fulfillment of the requirement for the degree of

MASTER OF DENTAL SURGERY
(BRANCH VI-PROSTHODONTICS)

MARCH 2009

CERTIFICATE

This is to certify that the dissertation titled **"Evaluation of Arc Of Closure Using Arbitrary Ear Piece Face Bow And Semi Adjustable Articulator"-An In vivo Study** is a bonafide record of work carried out by **Dr.S.VINAYAKAM**, during the period of 2006-2009. This dissertation is submitted in partial fulfillment, for the degree of Master of Dental Surgery awarded by Tamil Nadu Dr. MGR Medical University, Chennai in the branch of Prosthodontics. It has not been submitted partially or fully for the award of any other degree or diploma.

GUIDED BY

Dr C.SABARIGIRINATHAN,MDS,
Additional Professor
Dept. Of Prosthodontics,
Tamil Nadu Govt. Dental College
&Hospital, Chennai-3.

HEAD OF THE DEPARTMENT

Dr. C.THULASINGAM, MDS,
Professor and Head of the Dept,
Dept. of Prosthodontics,
Tamil Nadu Govt Dental College &
Hospital, Chennai- 3

PRINCIPAL

Dr.K.S.G.A NASSER, M.D.S
Tamil Nadu Govt Dental College &Hospital
Chennai-3

DECLARATION

I **Dr.S.VINAYAKAM**, do hereby declare that the dissertation titled **"Evaluation of Arc Of Closure Using Arbitrary Ear Piece Face Bow And Semi Adjustable Articulator"-An In vivo Study"** was done in the Department of Prosthodontics, Tamil Nadu Government Dental College & Hospital, Chennai 600 003. I have utilized the facilities provided in the Government dental college for the study in partial fulfillment of the requirements for the degree of **Master of Dental Surgery** in the specialty of **Prosthodontics (Branch VI)** during the course period **2006-2009** under the conceptualization and guidance of my dissertation guide**, Dr.C.Sabarigirinathan, MDS.**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

Signature of the PG student Signature of the HOD

Signature of the Head of the Institution

ACKNOWLEDGEMENT

I am extremely thankful to *Dr.C.THULASINGAM, MDS.* Professor and Head of the Department, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital for his constant guidance, encouragement, and monitoring during this study. I also thank him for the valuable guidance he has given throughout my post graduation.

My sincere thanks to *Dr.K.S.G.A.NASSER, MDS* Principal, Tamil Nadu Government Dental College and Hospital, for his kind help, and permitting me to use the facilities in the institution

I consider it my utmost privilege to express my sincere and heartfelt gratitude to my dissertation guide *Dr.C.SABARIGIRINATHAN, MDS,* Assistant Professor/ senior civil surgeon Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital for her able guidance and support he has rendered at various stages of the dissertation.

I am extremely thankful to, *Dr.A.MEENAKSHI, MDS.* Additional Professor,Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital, for her instant help, support and motivation she has rendered throughout this study.

I am thankful to *Dr M.KANMANI, MDS* Assistant Professor, for guiding and helping me throughout this study.

I also thank, *Dr. K.VINAYAGAVEL,,MDS, Dr.V.BALAJI, MDS Dr. T.JEYANTHI KUMARI MDS, Dr.G.GOMATHI M.D.S, Dr K.RAM KUMAR, MDS, , Dr V.HARISHNATH, MDS,* Assistant Professors for helping me at different stages of this study.

I thank *Dr.RAVANAN*, Professor, Dept. of Statistics, Presidency College, and Chennai for helping me to carry out statistical analysis of the various test results.

I am highly indebted to my family members, all my friends and my fellow post graduates who have helped me in several ways during the course of the study.

Above all I thank the *ALMIGHTY* for giving me the strength and courage to complete this monumental task.

CONTENTS

S.NO.	*CONTENTS*	*PAGE NO.*

INTRODUCTION

The modern face- bow was first introduced by Snow at the turn of the twentieth century. Face- bow helps to relate the arc of closure or hinge axis of the mandible to the cranium .The transfer of face- bow recording to the semi adjustable articulator helps the articulator to simulate the jaw movements more accurately, which in turn enables the operator to establish the occlusal contact with high degree of accuracy.[16]

Although the first modern face- bow is attributed to Snow, there were many investigators who earlier realized the importance of mounting the cast in a given positional relationship to the condylar mechanism.[16]

Bonwill used 10cm equilateral triangle to locate the median incisal point of lower teeth in his articulator. Authors Balkwill, Hayes et al made attempts to relate the median incisal point.[16]

Walker invented the "CLINOMETER" with this he was able to achieve a better position for the lower cast in relation to the condyle. In the early twentieth century Gysi constructed a device used to registering the condylar path which could also be used as a face- bow. At the same time Snow invented his instrument which later became the prototype of the modern face- bow.[16]

The articulator is an extremely useful instrument in the absence of the patient which simulates the patient's mandibular movements which are executed by the complex neuromuscular mechanism that programs mandibular movements. Articulators can simulate but cannot duplicate all possible mandibular movements.[32]

The articulator can be programmed with certain patient records that allow the operator and the dental laboratory technician to fabricate a restoration that will be physiologically and psychologically successful.[32]

Numerous articulators are available. Some are very simple in design with limited movements while others are very complex with numerous attachments and adjustments.[32]

The late Carl O Boucher summed up by stating "it must be recognized that the person operating the instrument is more important than the instrument.[32]

The hinge axis is defined as an imaginary line that passes through the center of rotation of each condyle of mandible. It's also called the axis of rotation or horizontal axis. Different methods have been advocated to locate and transfer the hinge axis to the articulator. Commonly there are two

methods of recording and transferring of hinge axis which are in existence, namely arbitrary and kinematic.[1]

Prosthodontic history is somewhat incomplete as to the origins of the thesis of a transverse horizontal axis. The first actual kinematic location was evolved through the California gnathological society under the leadership of Dr.B.B.McCollum and credit for the idea of the mechanical location of an axis was given to Dr.Harlam. The first location employed modified Snow face bow and consumed as much as 8 hours. Current devices have evolved from this first crude mechanism and its attendant theories and observation. Many present day fallacies may also be traced to this origin.[14]

A face- bow recording is an essential step for proper mounting of casts in the clinical practice of Prosthodontic and restorative dentistry. The importance of hinge axis location for different Prosthodontic procedures has been reported and various methods, equipment and head gear have been devised to locate this axis. Some face- bows use the external auditory meatus for reference and are reported to locate the axis accurately and automatically.[21]

The articulators range from simple cast relators capable of accepting a single static occlusal record to the fully adjustable articulators capable of

receiving and reproducing the face bow and other occlusal records to simulate entire range of jaw movements to a great extent.[32]

Articulators have a mechanical hinge axis that has a fixed horizontal position parallel to its base and perpendicular to the mid saggital plane .when a face bow record is used in conjunction with an articulator, the maxillary cast is mounted in a relationship to the axis, which now becomes the mechanical equivalent of the patients mandibular arc of opening and closing in the terminal hinge position.[32]

The proper use of an anatomic articulator is dependent upon an accurate face- bow transfer. The terminal hinge axis is generally accepted as the most stable reproducible point from which the maxillary casts can be mounted. The arbitrary method is still the most common method of determining the axis and is widely used in the process of complete denture construction.

This study was conducted to evaluate the precision of a few arbitrary methods of recording hinge axis and the arc of closure of ten edentulous subjects who are undergoing treatment for the complete denture prosthesis for the first time. By using different arbitrary methods, arc of closure

tracings are recorded using the semi-adjustable articulator with attached tracing device.

Aim and objectives of the study:

1. To evaluate the arc of closure tracing of the patient on a semi-adjustable articulator.
2. To evaluate the arc of closure tracing on a semi-adjustable articulator based on the Bonwill concept of occlusion.
3. To evaluate the arc of closure tracing on a semi-adjustable articulator using Denar reference point.
4. To compare the different arc of closure recorded with arbitrary face bow with patient's original arc of closure.

REVIEW OF LITERATURE

Harry Sicher (1956) [12] published an article on the biologic significance of the hinge axis determination in order to avoid rash conclusions and to understand the real significance of the hinge position .

Ulf Posselt (1957)[34] performed this study to further elucidate the terminal hinge movement up to 20mm of hinge axis opening by checking the relation of the axis points to the condyles and by recording the shift of kinematically established hinge axis .

Olle Borgh ,Ulf Posselt ,Dr.Odont (1958) [24] registered the opening hinge axis with the aid of kinematic face bow mounted on a semi adjustable articulator . The results obtained were found to corroborate with those obtained in an earlier study conducted by Kurth and Feinstein .

Lawrence A .Weinberg ,A.B(1959) [20] This articles purpose was to describe the hinge axis ,describe geometric and clinical methods of finding it ,describe its use ,determine whether there are one or two hinge axis ,discuss the mandibular motion patterns for opening and closing ,give clinical evidence of transverse hinge axis ,determine if

pinpoint accuracy in location of the transverse hinge axis is necessary and relate these factors to clinical practice .

Raymond Cohen (1960)[29] stressed the importance of the hinge axis and its practical application in the determination of centric relation .

Arne G .Lauritzen and George H .Bodner (1961)[3] determined the variations in the location of the true hinge axis points from the location of the hinge axis points determined by arbitrary means .

Arne G .Lauritzen and Lloyd W.Wolford (1961)[2] located the hinge axis on an experimental basis. The results indicate not only that a 10 degree range of movement is sufficient for hinge axis location but that when dentists experienced in axis location are tested on an experimental apparatus, the attainable accuracy in locating the center of the 10 degree arc is within 0.2 mm.

Lawrence a. Weinberg, **A.B (1961)**[19] describes the correlation between the maxillary arch and condylar motion and evaluates the effect of errors in the face-bow transfer. This evaluation led to the conclusion that the non kinematic face-bow mounting is an essential step in the construction of restorations that will require the least intraoral correction.

Vincent R Trapozzano and John B ,Lazzari (1961)[35] investigated whether there is a terminal hinge axis and if so ,whether or not only one exists. In majority of the case s more than one hinge axis points were located on either one or both sides.

Arthur E .Aull .(1963)[4]conducted a study on the transverse hinge axis and concluded that the horizontal axis is a hypothetical line connecting the 2 horizontal rotation centers of the 2 condyles of the mandible , the terminal hinge position is that position of the horizontal axis of the mandible when it is in its most posterior position, the terminal hinge position is a border position and the opening and closing movement of the jaw in its most posterior position is a border movement, the accuracy of location of the terminal hinge position is a matter of interpretation , an arbitrary point of location fails to satisfy the requirements of the path of closure, the experiments do not support the "split-axis" theory and no evidence to lead us to believe that there is more than one hinge location.

Walter R. Teteruck and Harry C.Lundeen(1966)[37] conducted a study comparing the accuracy of a new face –bow method and a conventional arbitrary method with true hinge axis technique . A standardized method of recording the location of the various points were described .

Robert P .Renner and Virgil M .S.Lau (1976)[30] eliminated some of the disadvantages of a kinematic hinge axis location for edentulous patients by modification of the Loma Linda hinge axis recording device and a face-bow for use on edentulous patients .

C.C.Beard and J.A.Clayton (1981)[5] initiated a study to determine the validity of the terminal hinge axis . The results of their study was compared with results obtained in an earlier study conducted by Trapozzano and Lazzari .

Mahmoud Khamis Abdel Razek (1981)[21] investigated to determine the reliability of five methods used to locate the arbitrary hinge axis when compared with the kinematic axis and to find if there are any sex or side location difference in the approximate position of the hinge axis .

P .F..Simonet and J.A.Clayton(1981)[25] determined the mechanical effect of the posterior horizontal table and vertical stylus, under controlled conditions. An articulator was used to control the variables. Recordings were made simultaneously during the same movement, with the stylus on one side moving and the stylus on the opposite side remaining stationary. With this set up, a number of variables were changed and their effects were examined.

Margaret Yanus ,Israel M. Finger and Roger Weinberg(1983)[22] determined whether cast mountings made with a mounting jig produce

significantly different results when compared to arbitrary face-bow mountings and to hinge-bow mountings and to determine whether face-bow record transfers are reliable (can be repeated

T.F.Lundeen and F. Mendoza(1984)[33] assessed the accuracy of the arbitrary hinge axis position in relation to the hinge axis position and to assess the effect of this error on the measurement of immediate Bennett shift .

Y.M.Balthazer G.J.Ziebert and Sara Jean Donegan (1984)[39] used a three dimensional format to describe the transverse axis displacements that arise from various interocclusal records . A comparison of the mandibular axis positions that resulted from centric relation records ,myocentric records ,and maximum intercuspation was performed .

Gabriel R.Zuckerman (1985)[10] depicted that the practical considerations for using the face bow for complete denture Prosthodontics in which the hinge axis position can be located by one of the several arbitrary methods .

Joyce F .Palik, Donald R.Nelson and James T. White (1985)[18] recorded variations between the kinematic axis and the earpiece-determined axis and measured the magnitude and direction between the two points on selected subjects. In addition, the significance of the difference between the

kinematic axis and the earpiece-determined axis was evaluated and the repeatability of the ear face-bow method was examined statistically.

Edwin H.Getz ,Maarshall S.Getz and Edwin S.Getz (1988)[9] presented a geometric method for determining hinge axis location by analysis of recorded extended arcs of rotation produced by opening movements of the mandible.

R.B.Gunderson and M.H.Parker (1987)[28] presented a technique that uses geometric principles to locate the mandibular transverse horizontal axis (hinge axis).

L.Abdal –Hadi (1989)[1] evaluated the precision of new arbitrary in relation to other commonly used arbitrary methods .

Gustaf Hellsing ,Eva Hellsing and Soren Elliason (1995)[11] designed this study to examine the TMJ condylar position in patients before and after a 4 to 7 mm increase in the occlusal vertical dimension (OVD) by use of a radiographic technique. The purpose of the investigation was to determine whether increasing the OVD would cause positional changes of the condyles in relation to their respective fossae.

Hussein S.Zaki ,Katalin J.Ketzan and Ivo Janecka(1995)[13] modified an ear face-bow to verify the position of strategic landmarks during construction of an orbital prosthesis. The modification of the slidematic

ear face –bow was performed by the incorporation of two symmetrically placed anterior reference pointers . The face bow was simple to use ,versatile ,and it can be sterilized . It can be used in the operating room during surgical re construction and for facial prosthetic restoration .

***Dae Gyun Choi, John F.B owley ,David B.Marx and Seung Lee*(*1999)*[8]** quantified the variability of the instrument and a group of dentists in performing an ear face-bow procedure . The ear face-bow was found to be a consistent method of articulating the maxillary cast .

Carlo Ercoli, Gerald N.Graser, Ross H.Tallents and Daniel Galindo (1999) [7] described an alternative procedure for face-bow transfer without a plane of reference, and uses the angular relationship between the occlusal plane and the condylar path to mount the maxillary cast on the articulator. The elimination of a reference plane, to which relate the functional determinants of occlusion, avoids an additional source of error during the mounting procedure.

Panayiota Hatzi ,Philip Millstein and Alvaro Maya(2001)[27]Determined whether mounted casts could be transferred from one articulator to another with positional accuracy and whether the hinge axis was reproducible in each of the articulator tested .

John F .Bowley and Steven M.Morgan.(2001)[15] investigated the magnitude and types of occlusal errors produced by deviations between patient's transverse horizontal axis and the axle of the articulator .

S.Parichereh Shodadai ,Jens C.Turp ,Thomas Gerds and Jorg R. Strub (2001)[31] evaluated the significance of an arbitrary face-bow registration and transfer is advantageous for the fabrication of an occlusal appliance in comparison with the omission of such a procedure .

Virgilio F.Ferrerio ,Chiarella Sforza ,Graziano Serrao and Johannes H.Schmitz (2002)[36] assessed the reliability of a new method to transfer the three dimensional orientation of the occlusal plane with a postural face – bow .

Wiiliam W.Nagy ,Thomas J.Smithy and Carl G.Wirth (2002)[38] compared the location of an anatomically predetermined hinge axis point with the determined kinematic axis . The results suggested that the predetermined axis point is well within the clinical norm for the transverse horizontal mandibular axis .

Olaf Bernhardt ,Nina Kuppers ,Michael Rosin and Georg Meyer (2003)[23] Measured the accuracy of the Cadiax compact system in a clinical series of tests and to determine whether there is a clinically

significant between three dimensional measurements recorded from a kinematically and arbitrarily determined transverse horizontal axes .

Jack D.Preston(2004)[14] briefly reviewed the history and development of the theory and practice of transverse horizontal axis location ,its application in clinical practice,and some of the controversies which have evolved around that use and to offer some clarifying concepts.

MATERIALS AND METHODS

This study was performed to evaluate the arc of closure of ten edentulous individuals recorded by using a few arbitrary methods of face bow recording. A total number of ten completely edentulous patients were selected from the outpatient wing of the department of Prosthodontics, Tamilnadu government dental college and hospital, Chennai. Out of the ten patients, 5 were male and 5 were female patients. The patients were selected and /or excluded based on the following criteria listed below.

SELECTION OF PATIENTS:

1. Patients undergoing denture construction for the first time.
2. Patients with considerably unresorbed ridges.
3. Patients with class1 skeletal relationship of the ridges.
4. Normal nuero muscular coordination.
5. Without any deviation on opening and closing.
6. No restricted mouth opening.
7. No clicking, popping, tenderness or pain in the temporo mandibular joints.
8. Age group of patients between 55 and 65 years.

The nature of the study was explained to each patient and an informed consent from each patient was obtained.

ARMAMENTARIUM:

1. An ear piece face bow
   - An U-shaped frame with a flag attached on the left side
   - Condyle rods
   - Upper bite fork
   - Orbital pointer
   - Locking clamps.
2. A semi- adjustable articulator.
3. Lower bite fork with a pencil mounted stylus.
4. Vernier caliper.

S.No	**NAME (commercial name)**	**FORM OF THE MATERIAL**	**MANUFACTURER DETAILS**
1	Customized lower bite fork with stylus	Customized lower bite fork with stylus	Custom made
2	Type AEB	Arbitrary Face Bow	Dentatus Sweden

	Dentatus Sweden		
3	Type ARH Dentatus Sweden	Class III semi adjustable Articulator	Dentatus, Sweden
4	Digital Vernier caliper	Vernier caliper	Aerospace

MATERIALS:

1. Type 2 dental plaster
2. Dental stone
3. Modelling wax
4. Sticky wax
5. Auto polymerizing resin
6. Graph sheets.
7. Colour pencils
8. Impression compound
9. Tracing compound
10. Zinc oxide Eugenol impression paste

.S.No	NAME (commercial name)	FORM OF THE MATERIAL	MANUFACTURER DETAILS
1.	Quick Ashwin	Chemically activated poly(methylmethacrylate) resin	Ashwin, India
2.	Cavex Set Up Hard	Modelling wax	Cavex, Holland BV
3.	Ultrarock	Die Stone Class IV	Kalabhai India
4.	Orthocal	Type 2dental plaster	Kalabhai ,India
5.	DPI Impression paste	Zinc oxide Eugenol impression paste	DPI,India
6.	DPI Tracing sticks	Green stick compound	DPI,India
7.	DPI Impression compound	Impression compound	DPI,India
8.	Sticky wax	Sticky wax	DPI,India

Face-bow: An ear piece face bow was used in this study. A flag with measured dimensions was fixed on the left side of the U shaped frame of the face bow. A graph sheet was pasted on the flag to record the arc of closure tracing of the patient as well as to record the arc of closure tracing using a semi adjustable articulator.

Customized bite fork: A bite fork with two prongs and a straight stem and a stylus to hold the pencil was designed. The pencil was secured tightly to the stylus by means of a screw. This customized bite fork was attached to the lower occlusal rim. The bite fork was designed and fabricated with the help of a lathe machine.

Methodology

Diagnosis and Impression Making: Edentulous individuals of age ranging from 55 to 65 years were taken up in this study. All the selected patients were in good health, normal neuromuscular co-ordination, and had relatively good ridges. All the patients were selected with Angle's Class I maxillo mandibular skeletal relationship. Primary impression was made with impression compound and primary casts were made with type II gypsum product. Custom trays were fabricated with chemically activated denture base resin with1.5mm wax spacer. Trays were trimmed and tried in the patient's mouth to check the extension. Then border moulding was done and secondary impression was made with Zinc Oxide Eugenol impression paste. Casts were poured with Type III dental stone. The denture base and occlusal rims were then made with auto polymerizing resin and modeling wax. A tentative jaw relation is recorded and it is followed by face bow recording.

PROCEDURE FOR EAR PIECE FACE- BOW TRANSFER:

The arc of closure tracings were done in four methods.

METHOD –I

The patient is seated in a comfortable position with his head held in an upright position and supported by the headrest .The midline for anterior teeth placement is marked on the maxillary occlusal rim taking reference from the patient's facial midline .The bite fork is heated and inserted into the labial and buccal surfaces of the maxillary occlusal rim and is kept parallel to the occlusal surface of the rim. The midline of the bite fork is coincided with the midline of the maxillary occlusal rim. The maxillary occlusal rim with attached bite fork is inserted in the patient's mouth.[16]

The U shaped frame of the ear piece face bow is positioned over the face and the bite fork stem is slipped through the hole in the clamp. Both the ear knobs are then inserted into the external auditory meatus and adjusted to get equidistant in the reading of graduated condylar rod and then the locking screws are tightened. The locking nuts and the clamp holding the bite fork are tightened ,gently at first and then firmly.The infra orbital notch is palpated and marked. The orbital pointer is

positioned in such a way it touches the infra orbital notch and is locked in position to the U frame with an orbital clamp.[16]

A customized bite fork with a pencil mounted stylus fixed to its stem is heated and inserted into the mandibular occlusal rim. The mandibular occlusal rim is then inserted into the patient's mouth. With the help of the tentative jaw relation recorded, the patient is guided to close in centric relation. After establishing the jaw relation the patient is asked to open and close the mouth from the retruded position of the mandible. The arc of closure is recorded on the device (flag) attached to the left side of the face bow. This is considered as the true arc of closure of the patient.

METHOD II: FACE BOW TRANSFER, RELATING THE PATIENT TO THE ARTICULATOR.

The ear piece clamps are loosened and the entire assembly of the face bow is slipped of the face together with the attached upper occlusal rim. Prior to the mounting, the cast is indexed. A sharp knife or a lathe is used to cut the index. Petroleum jelly is applied over the indexed portion. The bow is centered in the articulator with the help of condylar rods so that the maxillary occlusal rim is also placed in the

centre of the articulator. A plane of orientation using the orbital pointer is established.[16]

A cast support holds the weight of the occlusal rim and cast. Mounting plaster is used to attach the cast. The face- bow is then removed from the articulator. The lower occlusal rim is assembled on to the maxillary occlusal rim using the bite registration record. The upper and lower occlusal rims are sealed in centric relation. The articulator is turned upside down. The occlusal rims are seated on the maxillary cast. The mandibular cast is secured with the articulator using modeling plaster. Once the plaster sets the entire face- bow assembly is repositioned in the articulator using the maxillary occlusal rim and bite fork.[16] The customized bite fork with a pencil mounted stylus (colour coded) is repositioned to the lower occlusal rim on the articulator. After completing the repositioning of the face- bow and the tracing stylus the upper member of the articulator along with the face- bow is moved upwards and backwards in an arc .The arc of closure tracing is recorded on the graph sheet on the flag attached to the frame on the left side of the face- bow. The arc of closure tracing was recorded using a pencil mounted stylus fixed to the customized bite fork attached to the lower occlusal rim.

METHOD III-BASED ON BONWILL CONCEPT OF OCCLUSION.

According to Bonwill's theory of occlusion, the teeth move in relation to each other as guided by the condylar and the incisal guidances. Bonwill's theory is also known as the Theory of equilateral triangle according to which, the distance between the condyles is equal to the distance between the condyle and the midpoint of the mandibular incisors (incisal point). An equilateral triangle is formed between the two condyles and the incisal point. Theoretically, the dimension of the equilateral triangle is 4 inches.[6]

The Facebow recording procedure is repeated for the patient. Then the ear piece clamps are loosened and the entire face-bow assembly is slipped of the face together with the attached upper occlusal rim. The Face-bow is centered in the articulator with the help of condylar rods. The plane of orientation is established by the midplane of the articulator as marked on the incisal rod. The upper occlusal rim is positioned in such a way that the level of the anterior occlusal plane coincides with the central mark on the incisal rod of the articulator. A cast support holds the weight of the occlusal rim and cast. Modelling plaster is used to attach the cast. The face- bow is then removed from the articulator. The lower occlusal rim is assembled on to the maxillary occlusal rim using the bite registration record.

The upper & lower occlusal rims are sealed in centric relation. The articulator is turned upside down. The occlusal rims are seated on the maxillary cast. The mandibular cast is secured with the articulator using modelling plaster. Once the plaster sets the entire face bow assembly is repositioned in the articulator using the maxillary occlusal rim and bite fork. The customized bite fork with a pencil mounted stylus (colour coded) is repositioned to the lower occlusal rim on the articulator. After completing the repositioning of the face bow and the tracing stylus the upper member of the articulator along with the face- bow is moved upwards and backwards in an arc .The arc of closure tracing is recorded on the graph sheet on the flag attached to the frame on the left side of the face- bow. The arc of closure tracing is recorded using a pencil (colour coded) mounted stylus fixed to the customized bite fork attached to the lower occlusal rim.

METHOD-IV:BASED ON THE DENAR REFERENCE PLANE LOCATOR:

A Denar reference plane locator is used to locate the anterior reference plane which is marked 43mm above the upper bite block (occlusal rim) in the edentulous patient.[16]

The lower orbital margin of the patient is palpated and a line is drawn to mark the lower orbital margin. The lower orbital margin marked on

the patient and the distance between the lower orbital margin and the anterior occlusal plane of the maxillary occlusal rim is measured using a Vernier caliper. This measured distance is marked from the base of the articulator to a point on the incisal rod.[16] This point is used to orient the maxillary occlusal rim on the articulator. A face- bow recording procedure is repeated for the patient. The ear piece clamps are loosened and the entire face bow assembly is slipped of the face together with the attached upper occlusal rim. The face- bow is centered in the articulator with the help of condylar rods. The plane of orientation is established by orienting the anterior occlusal plane of the maxillary occlusal rim to the measured point marked on the incisal rod on the articulator. A cast support holds the weight of the occlusal rim and cast. Modelling plaster is used to attach the cast. The face- bow is then removed from the articulator. The lower occlusal rim is assembled on to the maxillary occlusal rim using the bite registration record.[16]

The upper & lower occlusal rims are sealed in centric relation. The articulator is turned upside down. The occlusal rims are seated on the maxillary cast. The mandibular cast is secured with the articulator using modelling plaster. Once the plaster sets the entire face bow assembly is repositioned in the articulator using the maxillary occlusal rim and the bite

fork The customized bite fork with a pencil mounted stylus (colour coded) is repositioned to the lower occlusal rim on the articulator. After completing the repositioning of the face bow and the tracing stylus the upper member of the articulator along with the a face bow is moved upwards and backwards in an arc .The arc of closure tracing is recorded on the graph sheet on the flag attached to the frame on the left side of the face- bow.

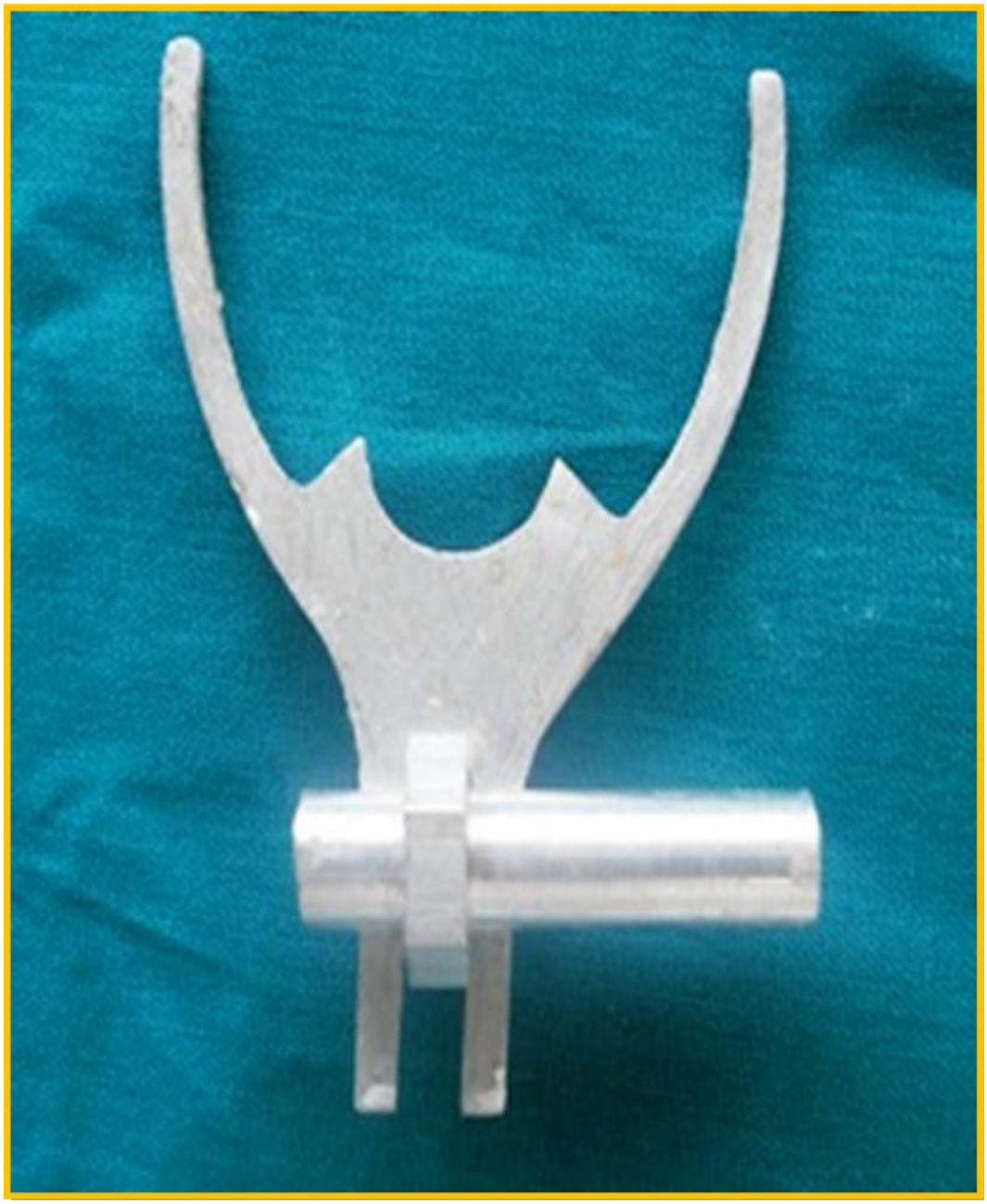
The arc of closure was recorded using a pencil (colour coded) mounted stylus fixed to the customized bite fork attached to the lower occlusal rim.

The original arc of closure of the patient scribed in the graph on the tracing flag is taken as reference and the other three arc of closure obtained in the articulator using three different arbitrary methods

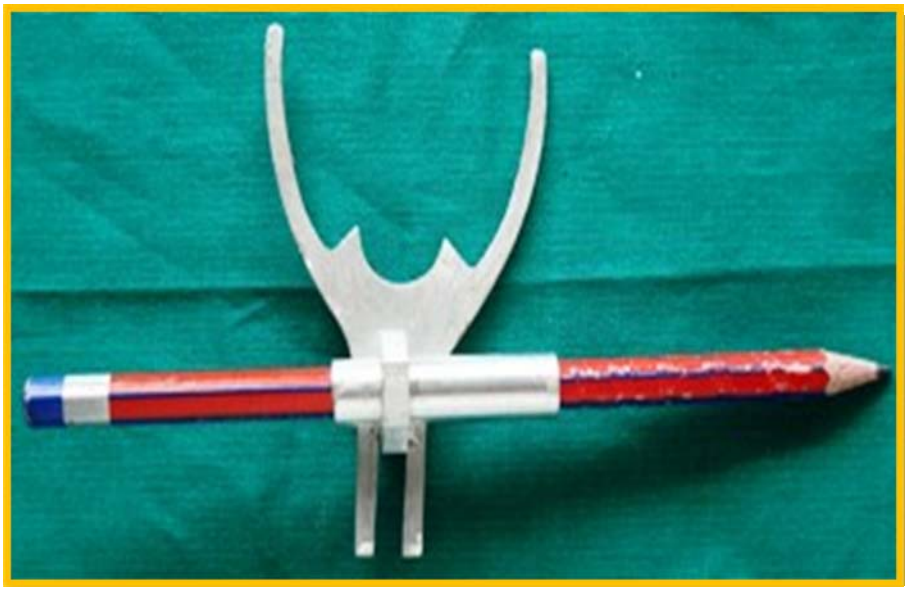
Photographs

ARMAMENTARIUM

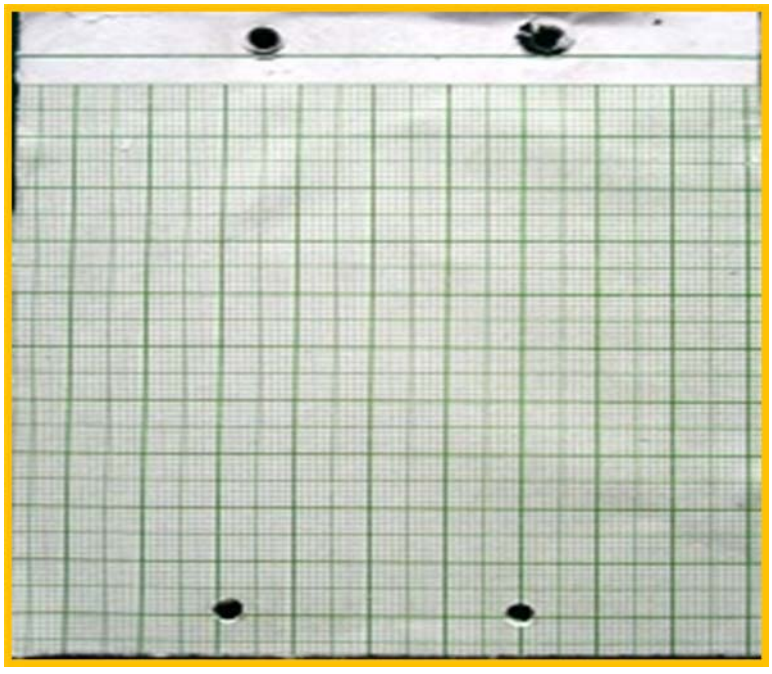
FACE-BOW WITH ATTACHED FLAG



CUSTOMIZED LOWER BITE FORK



CUSTOMIZED BITE FORK WITH TRACING STYLUS



GRAPH SHEET PASTED ON THE FLAG TO RECORD TRACING

FACE-BOW RECORDING

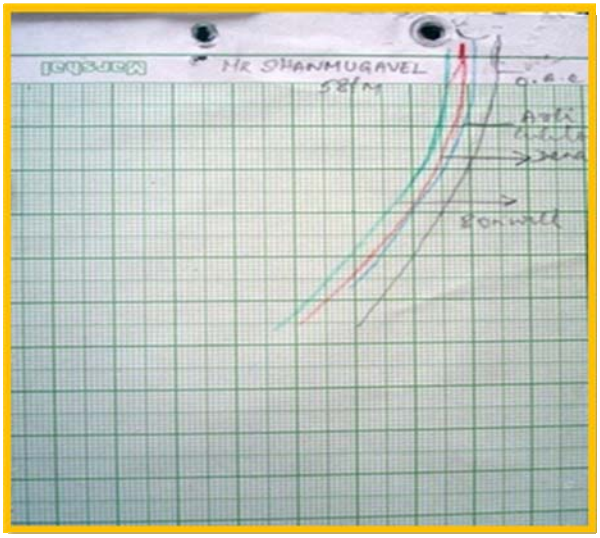
DENAR REFERENCE POINT MEASURED

DIGITAL VERNIER CALIPER

RELATING THE PATIENT TO THE ARTICULATOR

RELATING THE PATIENT TO THE ARTICULATOR BASED ON BONWILL CONCEPT

DENAR CONCEPT



ARC OF CLOSURE TRACINGS

RESULTS

Table I: The arc of closure tracing measurements for various groups based on different methods.

PATIENT	MEASUREMENT LOCATIONS	GROUP-A	GROUP-B	GROUP-C	GROUP-D
I	A	0mm	0.4mm	0.7mm	1.1mm
	B	0mm	0.5mm	0.9mm	1.2mm
	C	0mm	0.8mm	1.1mm	1.4mm
	D	0mm	0.7mm	1.2mmm	1.3mm
	E	0mm	0.8mm	1.3mm	1.4mm
S.D		0mm	0.18mm	0.24mm	0.13mm
MEAN		0mm	0.64mm	1.04mm	1.28mm
II	A	0mm	0.4mm	0.7mm	1.2mm
	B	0mm	0.5mm	0.9mm	1.2mm
	C	0mm	0.7mm	1mm	1.3mm
	D	0mm	0.8mm	1.1mm	1.4mm
	E	0mm	0.8mm	1.2mm	1.5mm
S.D		0.00mm	0.18mm	0.19mm	0.13mm
MEAN		0mm	0.64mm	0.98mm	1.32mm
III	A	0mm	0.4mm	0.8mm	1.6mm
	B	0mm	0.5mm	0.9mm	1.4mm
	C	0mm	0.7mm	1.1mm	1.1mm
	D	0mm	0.6mm	1mm	1.1mm
	E	0mm	0.7mm	0.9mm	1.3mm

S,D		0.00mm	0.13mm	0.11mm	0.21mm
MEAN		0mm	0.58mm	0.94mm	1.3mm
IV	A	0mm	0.6mm	0.9mm	1.2mm
	B	0mm	0.6mm	0.9mm	1mm
	C	0mm	0.5mm	0.8mm	1.4mm
	D	0mm	0.6mm	1.2mm	1mm
	E	0mm	0.4mm	1.1mm	1.2mm
S,D		0.00mm	0.57mm	0.89mm	1.23mm
MEAN		0mm	0.54mm	0.98mm	1.16mm
V	A	0mm	0.4mm	1mm	1.1mm
	B	0mm	0.4mm	0.9mm	1.1mm
	C	0mm	0.5mm	0.9mm	1.1mm
	D	0mm	0.6mm	1.2mm	1.2mm
	E	0mm	0.7mm	1.2mm	1.2mm
S.D		0.00mm	0.13	0.15mm	0.05mm
MEAN		0mm	0.52	1.04mm	1.14mm
VI	A	0mm	0.7	1.1mm	1.2mm
	B	0mm	0.6	1.2mm	1.3mm
	C	0mm	0.7	1.4mm	1.3mm
	D	0mm	0.6	1.2mm	1.4mm
	E	0mm	0.7	1.2mm	1.2mm

S,D		0.00mm	0.05	0.11mm	0.08mm
MEAN		0mm	0.66	1.22mm	1.28mm
VII	A	0mm	0.6	1.2mm	1.2mm
	B	0mm	0.8	1.1mm	1.2mm
	C	0mm	0.6	1.3mm	1.3mm
	D	0mm	0.6	1.2mm	1.3mm
	E	0mm	0.7	1.2mm	1.2mm
S.D		0.00mm	0.09	0.7mm	0.05mm
MEAN		0mm	0.66	1.2mm	1.24mm
VIII	A	0mm	0.5	1.2mm	1.3mm
	B	0mm	0.6	1.1mm	1.2mm
	C	0mm	0.9	1.2mm	1.3mm
	D	0mm	0.7	1.3mm	1.3mm
	E	0mm	0.8	1.2mm	1.4mm
S.D		0.00mm	0.16	0.7mm	0.07mm
MEAN					
IX	A	0mm	0.6	0.9mm	1.2mm
	B	0mm	0.5	1.1mm	1.2mm
	C	0mm	0.7	1.2mm	1.3mm
	D	0mm	0.6	1.3mm	1.4mm
	E	0mm	0.8	1.4mm	1.2mm

S.D		0.00mm	0.11	0.19mm	0.09mm
MEAN		0mm	0.64	1.18mm	1.26mm
X	A	0mm	0.5	0.9mm	1.3mm
	B	0mm	0.6	1mm	1.2mm
	C	0mm	0.8	1.1mm	1.2mm
	D	0mm	0.6	1.1mm	1.4mm
	E	0mm	0.8	1.2mm	1.3mm
S.D		0.00mm	0.13	0.11mm	0.08mm
MEAN		0mm	0.66	1.06mm	1.28mm

Table I depicts the arc of closure tracing measurements for various groups based on different methods. In this table arc of closure tracing scribed by the patient was categorized under Group A. This was considered as the control group. Five markings , each 1cm apart were made on the arc of closure tracing scribed by the control group(Group A). The arc of closure tracings recorded , based on a few arbitrary methods, with the help of a semi adjustable articulator were categorized under Group B ,Group C and Group D. The proximity of the arc of closure tracings of Group B , Group C and Group D to that of the control group (Group A) were

assessed by measuring the distance from five different locations on the arc of closure tracing of the control group (Group A).

Table – II : Mean and standard deviation of different measurement locations among various groups.

GROUP-A		GROUP-B		GROUP-C		GROUP-D	
MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)
0	0	0.51	0.11	0.94	0.18	1.24	0.14
0	0	0.56	0.11	1	0.12	1.2	0.11
0	0	0.69	0.12	1.11	0.17	1.27	0.10
0	0	0.32	0.25	0.52	0.44	0.56	0.55
0	0	0.35	0.21	0.56	0.34	0.62	0.42

TABLE-III : SUMMARY OF ANOVA TEST RESULTS				
ANOVA TABLE	SS	DF	MS	PVALUE

TREATMENT BETWEEN COLUMNS	9.537	3	3.179	
REIDUAL (WITHIN COLUMNS)	0.2063	36	0.005731	
TOTAL	9.743	39		
NEWMANKEUELS MULTIPLE COMPARISON TEST	MEAN DIFFERENCE	Q	SIGNIFICANT	P<0.0001
GROUP-A Vs GROUP-D	-1.266	52.88	***	
GROUP-A Vs GROUP-C	-1.084	45.28	***	
GROUP-A Vs GROUP-B	-.634	26.48	***	
GROUP B Vs GROUP-D	-.632	26.40	***	
GROUP-B Vs GROUP-C	-.45	18.80	***	
GROUP-C Vs GROUP-D	-.182	7.60	***	
*** -DENOTES SIGNIFICANT AT 1% LEVEL				

INTERPRETATION OF RESULTS

The basic data of the results of this study are shown in annexure from Table I to Table III. In this study ,the proximity of the arc of closure tracings which were obtained using a few arbitrary methods on a semi adjustable articulator was compared with the arc of closure obtained from the patient using an ear piece arbitrary face bow.

Then, the results were analyzed using the following statistical analysis. One way ANOVA test was used to assess the significant difference between different groups based on arc of closure tracing measurements.

Table I depicts the arc of closure tracing measurements for various groups based on different methods and also shows the mean and standard deviation of the various groups.

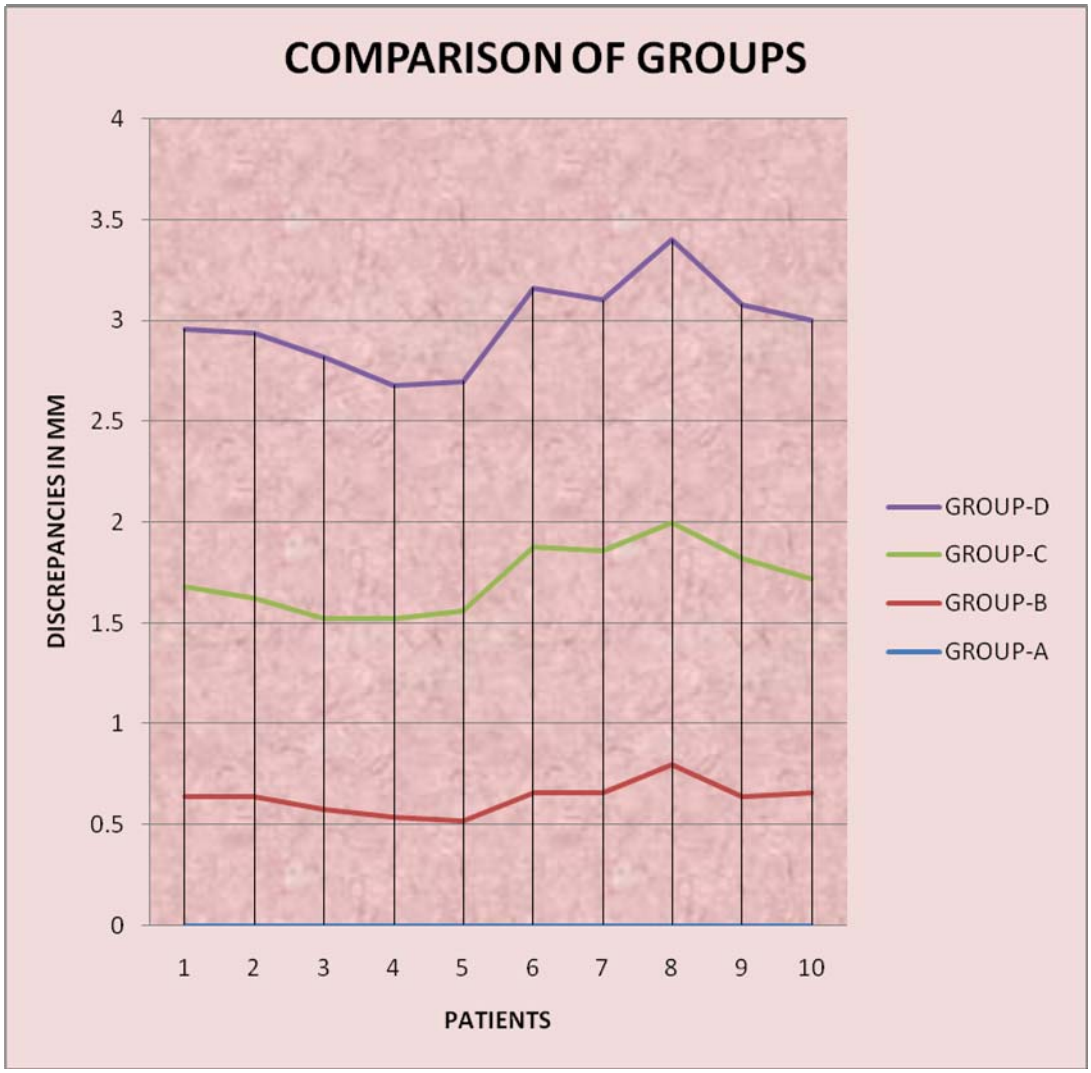
Table II depicts mean and standard deviation of different measurement locations among various groups.

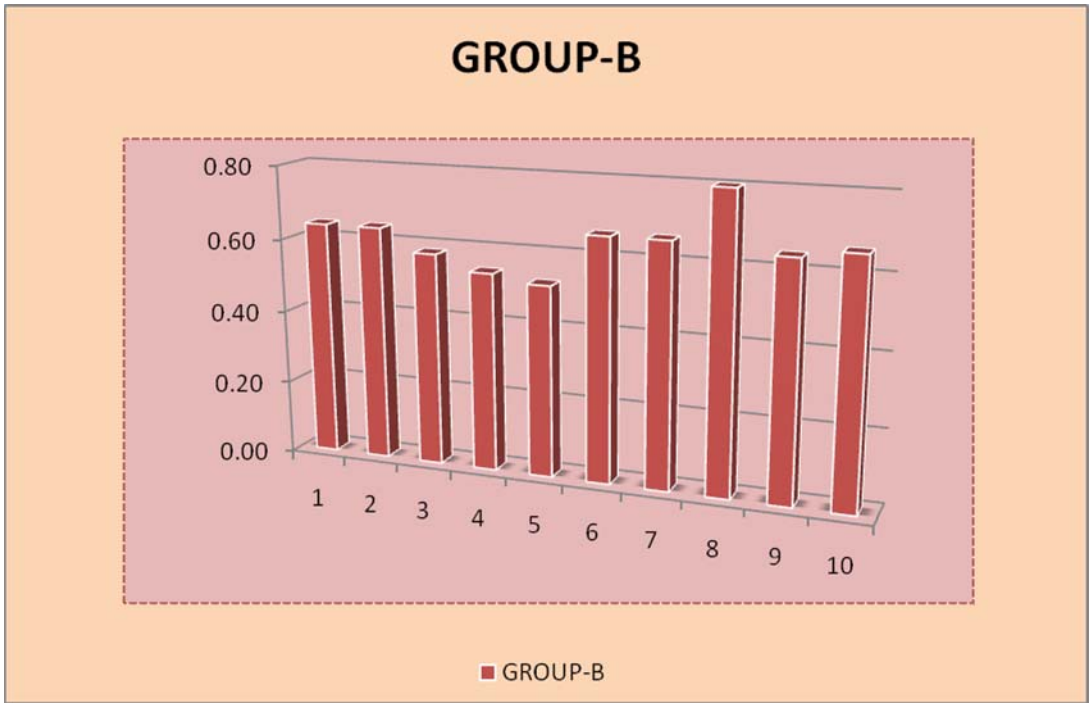
Table III shows the statistical evaluation of one way ANOVA test between different groups. ANOVA results show that the treatment between the columns and the residual within the columns were statistically significant at1% level.

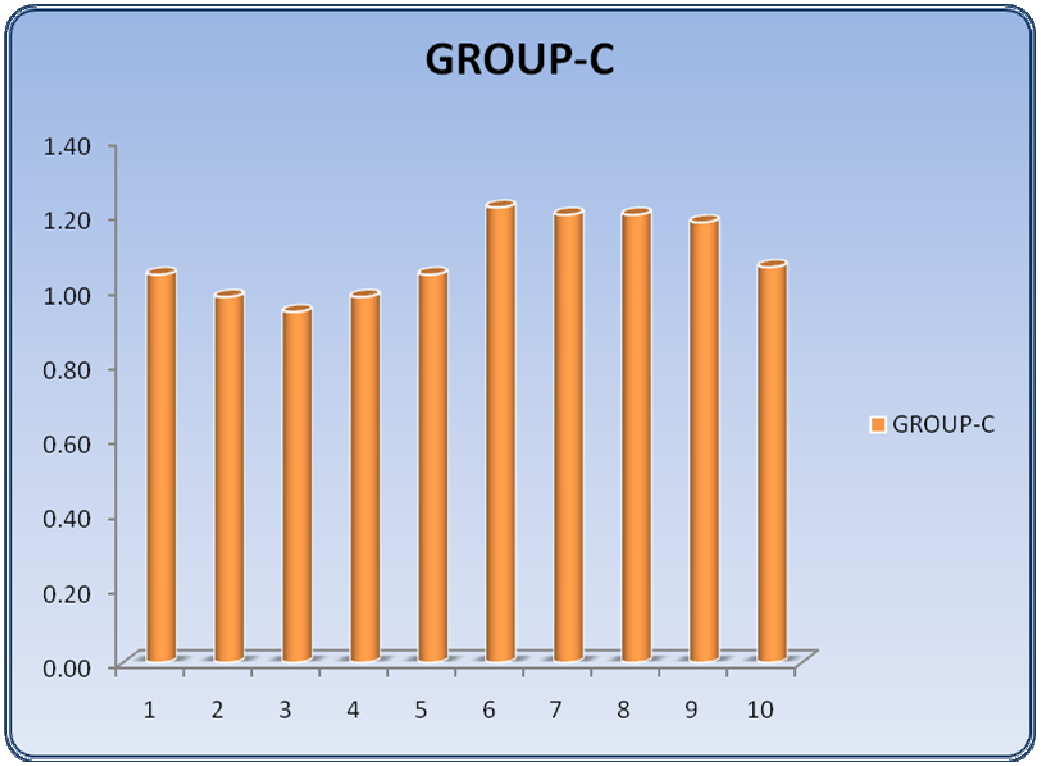
In table III, NEWMAN KEULS multiple comparison test depicts the different groups were statistically significant at 1% level such as

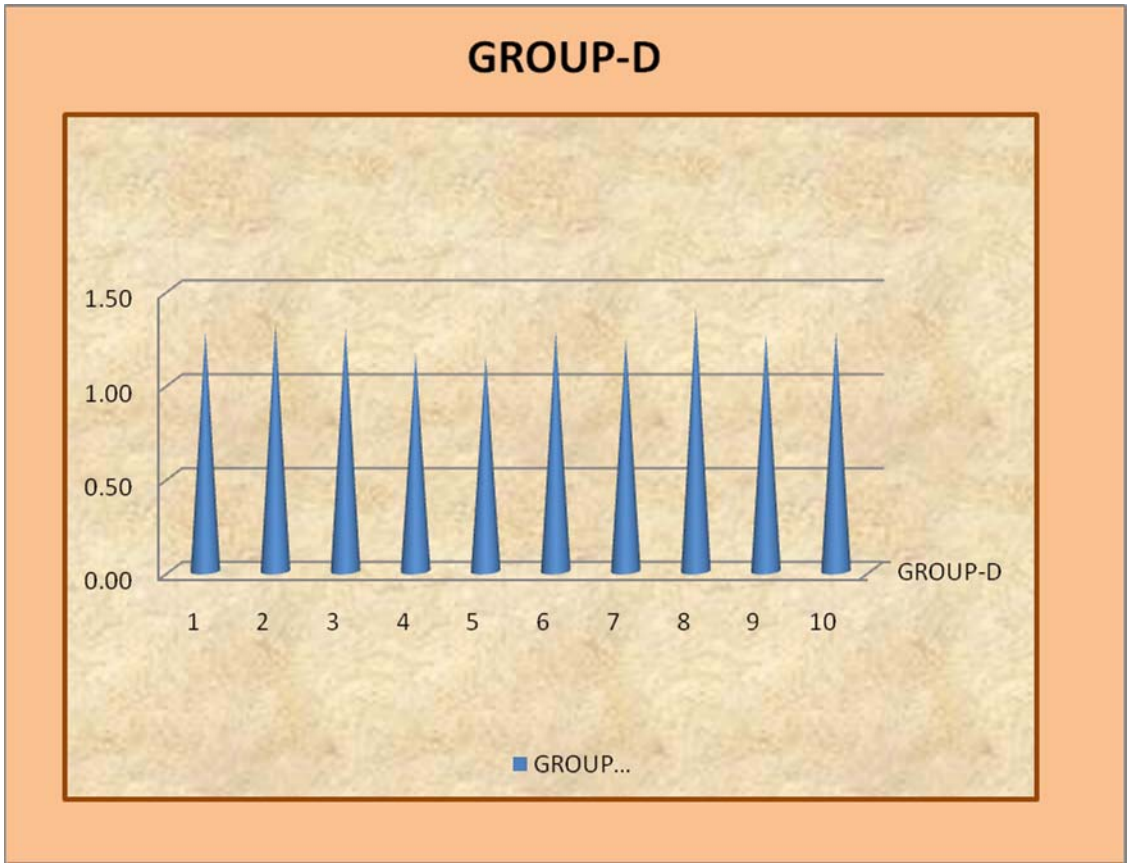
1. Group A Vs Group D
2. Group A Vs Group C
3. Group A Vs Group B
4. Group B Vs Group D
5. Group B Vs Group C
6. Group C Vs Group D.

Bar Diagrams


COMPARISON OF GROUPS
DISCREPANCIES IN MM
4
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
PATIENTS
GROUP-D
GROUP-C
GROUP-B
GROUP-A


GROUP-B
0.80
0.60
0.40
0.20
0.00
1
2
3
4
5
6
7
8
9
10
GROUP-B


GROUP-C
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
2
3
4
5
6
7
8
9
10
GROUP-C


GROUP-D
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
GROUP-D
GROUP...

DISCUSSION

This study was conducted to evaluate the precision of a few arbitrary methods of recording hinge axis and the arc of closure of ten edentulous subjects who are undergoing treatment for complete denture prosthesis for the first time . By using different arbitrary methods ,arc of closure tracings were recorded using meatus type arbitrary face-bow and a semi-adjustable articulator with attached tracing device . Three types of arbitrary methods were used in this study viz. meatus type arbitrary face-bow using infra orbital notch as anterior reference point, the Bonwill concept of occlusion and the Denar reference point .

Many dentists use arbitrary posterior reference points based on average, anatomic landmarks considered reasonably accurate for most clinical situations. The rationale for the use of arbitrary reference points is based on expediency.[28]

The concept of the ear face-bow is not new. Although not the ultimate answer for condylar axis location, the ear face-bow technique has clear advantages over the most widely used method of arbitrary axis location. The accuracy, speed of handling, and simplicity of orienting maxillary casts with the ear-piece face-bow are recommendations for its use in many routine restorative procedures.[37] On the other hand, 56.4% of the

arbitrary points achieved by the ear face-bow fell within a 6mm radius of the true hinge axis. By calculating the epicenter of the greatest concentration of hinge axis points from the original data and modifying the mounting holes in the ear plugs to this new centre, it was estimated that the values could be increased to 75.5%.[37]

While it is desirable to place an arbitrary axis as close as possible to the kinematic one , the results obtained indicate that none of the arbitrary methods used were ideal for locating the hinge axis .There was also a wide range in the approximate position of the axis in different individuals, which suggests the unreliability of arbitrary guides for universal application .The position of kinematic axis in relation to tragus- canthus line was found to vary from the data obtained by other investigators. This difference is probably a racial one.[21]

The findings suggest that the palpation method can be accepted for locating the condyle axis. The 2mm difference is considered acceptable on any mounting that is to be articulated reasonably close to the correct vertical dimension of occlusion .In all methods tested, it was found that there were no significant differences between men and women or between left and right side location measurements. This investigation suggests that an accurate axis location necessitates a combination of the

above arbitrary methods.[21]

Weinberg and schallhorn concluded mathematically and experimentally that reasonable errors in the transverse hinge axis location (±5mm) produce extremely small antero posterior mandibular displacement when the centric relation record is removed and the articulator is closed. Approximately 0.2 mm of displacement at the second molar region can be detected.[22]

Boucher stated that when the mandibular cast is transferred to articulator by means of centric relation record made at the correct occlusal vertical dimension , the arbitrary hinge axis may be adequate.[22]

In this study , all the subjects were free of signs and symptoms of temporomandibular disorders . The characteristics of all recorded tracings were within the range of normal curvature.[23]

If centric relation is recorded at the established vertical dimension of occlusion, the occlusal error is zero at that position. No error is found at 0 degrees of mandibular opening. Recording media that allow minimal amount of mandibular opening during the recording procedure should be used . If an arbitrary face- bow record is used, the same clinical procedure should be followed to avoid development of occlusal

errors.[17] If the vertical dimension of the wax record be a thick one, or if opening and closing the vertical dimension of the casts on the articulator is anticipated, then the true hinge axis should be located on the patient and transferred to the articulator . Because occlusal errors might occur when average value articulators that do not use a face-bow are used ,the centric relation position be recorded at or close to the established vertical dimension of occlusion.[17]

Arbitrary axis points determined from anatomical landmarks are popular due to their ease of use compared to the trial and error method of locating the kinematic axis . It has been demonstrated mathematically that location of an arbitrary axis point ± 5 mm anterior – posterior to the kinematic axis will result in negligible error (0.2 mm) on the nonworking side when a 3mm – thick centric relation record is used.[38]

Preston , however, indicated that a superior-inferior error will produce a greater error than a comparable anterior-posterior error. While the kinematic axis is preferable and can usually be located within 1 mm of accuracy, it is technique sensitive and requires good visual acuity .[38]

The search continues for an easily located anatomic axis point that consistently falls within 5 mm radius guidelines. Many studies have evaluated the deviation of arbitrary points to that of the kinematic center. Most recognize the inconsistencies in locating soft tissue land marks and their individual variability and the fact that a significant percentage of points do not fall within the 5 mm radius of the kinematic axis.[38]

Schallhorn reported 95% correlation and walker only 20% correlation with the use of common estimated points. Most points fall within 50 % to 75% range.[38]

The ear Face-bow that makes use of the external auditory meatus and nasion was one attempt to solve the problem of identifying anatomically determined arbitrary axis points. This system became widely popular with the introduction of Quick mount face –bow in the early 1960s. Rickets has reported that variations in ear anatomy may contribute to ear-bow error.[38]

Several studies have evaluated earpiece-type facebows and their relationship to the kinematic axis and other estimated points. The Bergström point is a common denominator to ear piece face-bows and has long been considered one of the most accurate arbitrary points. Bergström made use

of an arbitrary axis located automatically by his face-bow 10 mm anterior to the center of a 1-cm spherical insert for the external auditory meatus and 7 mm below the Frankfort horizontal plane. The face-bow required only orientation to the left orbitale. His articulator axis was positioned 10 mm anterior to the point of attachment for the face-bow and 7 mm below Frankfort plane; the face-bow and articulator worked in combination. Beck reported that the point was 4.1 mm from the kinematic axis and the most accurate of the points tested.[38]

Lauritzen et al used a Richey condyle marker in the external auditory meatus and marked a line with a ruler from the top of the marker to the outer canthus of the eye. The condyle marker was rotated to make an intersecting line 13 mm from the anterior side of the earpiece. The Lauritzen method was used to determine the kinematic axis points. The authors found that only 33% of the kinematic points were within a 5-mm radius of the arbitrary points in the study.[38]

Teteruck et al used an early version (forward-facing earpieces) of the QuickMount face-bow (WhipMix Corp). The nasion relater positioned the anterior crossbar in the region of orbitale (nasion minus 23 mm). The

Lauritzen method also was used to locate the kinematic axis points. Fifty-six percent of the earbow points were within 6 mm of the kinematic axis in their study. If the earbow mounting hole was repositioned, 75% would have been within 6 mm of the kinematic point. Current earbows have the repositioned mounting holes.[38]

Palik et al evaluated the Hanau 159-4 earpiece face bow . An orbital pointer positioned on the infraorbital foramen was used as the anterior reference. Maxillary casts were mounted on a Hanau 158-3articulator with the use of an infraorbital flag (orbitale minus 7). The Lauritzen method was used to locate the kinematic axis with a Hanau 135-6 face-bow . The earbow was repeated 4 times for each subject and the points marked on disks located lateral to each articulator condylar element. Fifty percent of the arbitrary points were within a 5-mm radius of the kinematic axis. However, 89% were within a 6-mm radius.[38]

The authors concluded that this earpiece face-bow method was not statistically repeatable. Three other studies investigated earpiece-type face-bows but did not directly measure the distance of an arbitrary point from the kinematic axis. It is interesting to note, however, that one study showed that direct palpation of the opening and closing axis of the mandible

(Dawson method) located an axis point 0 to 4 mm from the kinematic axis.[38]

Accurately mounted casts should look like the patient, with a correct midline, anterior incisal plane, and relationship to the reference horizon. The Facebow transfer of the maxillary cast ideally should be reproducible with clinically acceptable accuracy from mounting to mounting. This has been a difficult task, however, because of the lack of an anatomically recognizable reference position. The protocol for application of each point also has been skewed with time.[38]

In 1860 Langer I examined postmortem anatomic sections and observed that the condyles seemed to be stationary during small movements. This observation was later confirmed by other investigators. Photographic recordings, profile radiographs, and graphic methods , are other methods that have been used to investigate the rotation axis.[11] Two such studies concluded that a posterior hinge opening and closing movement is not possible in the living person. Controversies have persisted over the years on the transverse horizontal axis location and its applications in clinical practice. An excellent literature review on this topic was published by Preston, 11 in which he concluded that "a single transverse horizontal axis

can usually appear to be located" and that this is a worthwhile clinical procedure.[11]

The TMJ is well protected under the skull base and difficult to investigate either clinically or by radiographic examination. Rotational and postural changes of the condyle are therefore difficult to demonstrate. This may be one of the reasons why few objections have been raised to refute the hinge axis concept. The radiographic subtraction technique has made it possible to define small changes in hard tissue configurations and condylar positions.[11]

Jaw opening movement done under retrusion of the mandible was mainly rotational in character. A slight change of position (range 0.31 to 1.84 mm) was, however, noted for all condyles under study. The direction and amount of movement varied not only among subjects, but also between the two condyles of each subject. It may be concluded that a purely rotary movement about the transverse horizontal axis did not occur.[11]

The 2 anterior reference positions, palpation of orbitale compared with the manufacturer's recommended arbitrary 43-mm point vertical from a point angle of lateral incisor, are not the same points and might lead to a variation in the mounted position of the maxillary cast. Variations of

these 2methods of anterior reference-point determination warrants further study to determine differences in technique and consistency.[8]

In comparison studies of variations between the arbitrary axis and the kinematic axis, results varied from 20% to 95% of the arbitrary hinge axis points, falling within a 5 mm radius of the true hinge axis point. The difference in results may be due to the variation in methods and equipment used to locate the terminal and arbitrary hinge axes, the sample size or selection, measurement techniques, jaw manipulation, and operator variance.[18]

An acceptable deviation of a 5 mm radius has been reported repeatedly for the difference between an arbitrary hinge axis and the terminal hinge axis. Only 50% of the arbitrary hinge axes located with the ear-bow in this study were within a 5 mm radius. This indicates that the arbitrary ear-bow hinge axis location does not represent the total population. In addition, this research substantiates the work of Teteruck and Lundeens which indicated that 56% or most arbitrary hinge axes for the ear-bow fall anterior and inferior to the terminal hinge axis location. [18]

No inference should be made that the earpiece Facebow does not possess a practical clinical value. However, there is no consensus that the ear-bow approximates the terminal hinge axis within the acceptable range.

Further modifications are needed in the condylar compensators of the arbitrary face-bow to increase its accuracy. This study suggests that the arbitrary location of the terminal hinge axis incorporated in the condylar compensators of this ear-bow is misleading, because 92% of the clinically located terminal hinge axes were posterior to the ear-bow position. This suggested that the arbitrary hinge axis should be located less than 13 mm from the external auditory meatus. Additional research is needed to determine this distance by using a reliable terminal hinge axis locator.[18]

The most common plane used as reference for the face-bow transfer is the Frankfurt plane (porion orbitale), which was first conceived for the orientation of skulls in anthropology in the late nineteenth century. This plane appeared horizontal when the skull was put in the natural head position (NHP), the position of the head established with the subject standing and looking at the horizon. This plane was later applied in dentistry for a “natural” orientation of the head for cephalometric films and orientation ofdental casts in articulators because the porion is a radiographic landmark not directly visible in living subjects. Some systems use the axis point to determine a new plane (axis-orbitale). It has been assumed that this plane and the hard-tissue Frankfurt plane were roughly coincidental.[36]

In most articulators, the upper and lower members are parallel to each other and to the true horizontal when the incisal pin is set at zero. The occlusal plane and the condylar inclinations are usually transferred to the upper member of the articulator with the assumption that the Frankfurt plane and the axis-orbitale plane are parallel to the ground however, previous studies have shown that in NHP, the Frankfurt plane is extended, with the orbitale higher than the tragus or transverse horizontal axis.[36]

Alignment of maxillary casts according to the Frankfurt plane and the axis-orbitale plane therefore implies inadequate mounting in articulators with a design assumption that places the axis and the orbitale on a plane parallel to the true horizontal. The result is an overly steep angulation of the occlusal plane with the incisal edges of the maxillary anteriors placed too inferiorly when compared to NHP. The use of NHP in conjunction with the true horizontal plane can limit individual an racial variations that have been commonly described for the classic intracranial reference planes and eliminate the described orientation errors that occur when the maxillary casts are mounted in the articulator.[36]

The goal of the face-bow transfer procedure is to detect the anterior-posterior and vertical relationship of the maxilla to the THA and to transfer this relationship to the articulator. A number of factors may produce incorrect maxillary cast alignment: (1) individual variation in the anatomic reference landmarks and measurements, (2) improper adjustment of theface-bow to the patient or the instrument to the articulator during the transfer procedure, and (3) setting the Frankfurt plane horizontally on the upper member of the articulator is convenient to use but may introduce variables in the transfer procedure. The relative position of anatomically defined landmarks is influenced by racial variation, gender differences, and operator expertise in the identification of markers.[36]

In addition, the arbitrary landmarks and measurements used are based on average values designated on the basis of normative data, which may be unsuitable for subjects with large differences in size or shape as a result of age, gender, or facial asymmetry. The conventional face-bow recording relates a maxillary cast to the condylar assemblies of an articulator and the Frankfort plane, and it is assumed to reproduce the spatial orientation of the patient's maxilla.[36]

SUMMARY AND CONCLUSION

This study was performed to evaluate the accuracy of face-bow recording and the arc of closure of the individuals by using three different methods of face-bow recording with the help of arbitrary face –bow and semi adjustable articulator .

The accuracy of the arc of closure tracings recorded using an ear – piece face –bow were compared clinically with the arc of closure tracings recorded ,using a few arbitrary methods , with the help of a semi-adjustable articulator .The study was conducted with 10 completely edentulous patients who are going to wear the complete denture for the first time .

This study demonstrated a significant statistical difference between the arc of closure recorded using an ear piece face bow and the arc of closure recorded, based on a few arbitrary methods, with the help of a semi adjustable articulator from the results of the study. The arc of closure tracings recorded in method and categorized under Group B was found to be more nearer to the original arc of closure scribed by the patient on the recording device attached to the ear piece face-bow.

Furthermore, the arbitrary ear-piece face-bow method is not accurate in transferring the face-bow recordings and arc of closure. The usage of arbitrary face-bow in complete denture patients has been executed

successfully for so many years. Hence the arbitrary face-bows can be used successfully within their limitations.

APPENDIX

APPENDIX-1

INSTITUTIONAL ETHICAL COMMITTEE

TAMIL NADU GOVERNMENT DENTAL COLLEGE AND HOSPITAL

CHENNAI – 600 003.

Telephone: 044-2534 0441

Fax : 044-2534 0681

Date:

Title of the work **AN EVALUATION OF THE ARC OF CLOSURE USING AN ARBITRARY FACE BOW AND A SEMIADJUSTABLE ARTICULATOR**

-AN INVIVO STUDY

Principal investigator **Dr S.VINAYAKAM.**

III M.D.S.

Department Department of Prosthodontics

Tamil Nadu Government Dental College and Hospital,

Chennai-600 003.

The request for an approval from Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 27.11.2008 at the PRINCIPAL CHAMBER, TNGDC & H, Chennai-3.

The members of the Committee, the Secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The principal investigator and their team are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients / participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate from the area of the work for which you applied for ethical clearance.
5. You should inform the IEC immediately, in case of any adverse events or reaction.
6. You should abide to the rules and regulation of the institution.
7. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.
8. You should submit the summary of the work to the ethical committee on completion of the work.
9. You should not claim funds from the Institution while doing the work or on completion.
10. You should understand that the member of IEC have the right to monitor the work with prior intimation.

CHAIRMAN & PRINCIPAL

IEC, TNGDC & H, CHENNAI

APPENDIX-2a

INFORMED CONSENT FORM

TITLE OF WORK: AN EVALUATION OF THE ARC OF CLOSUR USING ARBITRARY FACE BOW AND A SEMIADJUSTABLE ARTICULATOR.

Name : _____ **O.P.No.:** _____

Address : _____ **Case No.:** _____

_____ **Age** : _____

_____ **Sex** : _____

I, _____ Age _____ Yrs, exercising my free power of choice, hereby give my consent to be included as a participant in the clinical study. I agree to the following:

I have been informed to my satisfaction about the purpose of the study, nature of the treatment, follow-up visits and study procedures including investigations, to monitor and to safeguard by body function.

I understand that the clinical procedure will require measurement of jaw relations.

I have informed that I have to wear a Face-bow for positioning of the upper cast in articulator.

I agree to co-operative fully and inform the dentist immediately if I suffer any unusual symptoms.

I have informed the dentist, about all medications and dental treatments that I have taken in the recent past and those I am currently taking. I shall not take any medications without the concern of the dentist.

I understand that dentist may stop my participation from the clinical study for any reasons. I am also aware of my right to opt out of the study at any time during the clinical study duration without giving any reason.

I hereby give permission to use my records for research purpose and I am told that study institution and dentist will keep my identity confidential.

_____	_____
Name of the Patient	**Signature & Date**
_____	_____
Name of Impartial Witness	**Signature & Date**
_____	_____
Name of the Investigator	**Signature & Date**

ஆராய்ச்சி ஒப்புதல் படிவம்

ஆராய்ச்சி தலைப்பு:-
"ஜெலட்டின் சைமோகிராபி ஆய்வைக் கொண்டு, ஈறுநோயின் திசு வெள்ளை அணுக்கள் பிரிவைச் சேர்ந்த மெட்ரிக்கள், மெடலோ பிரோட்டினேஸின் அளவும் அதன் செயல்பாடும் குறித்து ஓர் ஆய்வு".

பெயர் : _____ புற நோயாளியின் எண் : _____
முகவரி : _____ ஆராய்சசி சேர்க்கை எண் : _____
_____ வயது : _____
_____ பாலினம் ☐ ஆண் ☐ பெண்

நான் ..... வயது ..... என்னுடைய சுயநிநைவுடன் மற்றும் முழு சுதந்திரத்துடன், இந்த மருத்துவ ஆராய்ச்சி என்னை சேர்த்துக் கொள்ள சம்மதிக்கிறேன்.

எனக்கு விளக்கப்பட்ட விஷயங்களுக்கு நான் எனது சம்மதத்தை தருகிறேன்.

- இந்த ஆராய்ச்சியின் நோக்கம், மருத்துவ முறைகள் பரிசோதனை முறைகள் எனக்கு திருப்தியுறும் வகையில் விளக்கப்பட்டன.
- பரிசோதனை செய்வதற்காக என் உடம்பிலிருந்து வேண்டாத பல் புறத்திசு எடுக்கப்பட வேண்டியுள்ளதாக அறிகிறேன்.
- நான் எடுத்து வருகின்ற மற்றும் முன் உட்கொண்ட மருந்துகள் பற்றிய விவரங்களை ஆராய்ச்சியாளரிடம் அறிவிக்க சம்மதம்.
- என் உடல்நலம் பாதிக்கப்பட்டாலோ அல்லது எதிர்பாராத, வழக்கத்திற்கு மாறான நோய்குறி தென்பட்டாலோ உடனே அதை மருத்துவரிடம் தெரிவிப்பேன் என உறுதியளிக்கிறேன்.
- எனக்கும் மற்றும் மருந்து ஆராய்ச்சியாளருக்கும் இந்த ஆராய்ச்சியிலிருந்து எந்த ஒரு நிலையிலும் விலகுவதற்கோ அல்லது விலக்குவதற்கோ முழு உரிமை இருப்பதாக அறிகிறேன்.
- என்னுடைய மருத்துவக் குறிப்பேடுகளை இந்த ஆராய்ச்சியில் பயன்படுத்திக் கொள்ள சம்மதிக்கிறேன், ஆராய்ச்சி மையமும், ஆராய்ச்சியாளரும் என்னுடைய பெயர் மற்றும் சில விவரங்களை இரகசியமாக வைப்பதாக அறிகிறேன்.

நோயாளியின் பெயர்	கையெழுத்து	தேதி
ஆராய்ச்சியாளரின் பெயர்	கையெழுத்து	தேதி

BIBLIOGRAPHY

1. **Abdal-Hadi**. The hinge axis: Evaluation of a current arbitrary determination methods and a proposal for a new recording method. J Prosthet Dent 1989;62(4):463-467

2. **Arne G .Lauritzen ,Llyod W .Wolford** .Hinge axis location on an experimental basis .J Prosthet Dent.1961; 11(6):1059-1067 .

3. **Arne G.Lauritzen ,George H. Bodner .**Variations in location of arbitrary and the true hinge axis points .J Prosthet Dent.1961; 11(2):224-229 .

4. **Arthur E .Aull .**A study of the transverse axis .J Prosthet Dent .1963 ;13(3):469-479

5. **C.C.Beard, J .A.Clayton .**Studies on the validity of the terminal hinge axis .J Prosthet Dent .1981;46(2):185-191.

6. **Carl O Boucher,Zarb,Bolender.**Prosthodontic Treatment for Edentulous Patients-Complete Dentures and Implant –Supported Prosthesis.Twelfth Edition.

7. **CarloErcoli ,Gerald N.Graser ,Ross H Tallents ,Daniel Galindo .**Face –bow record without a third point of reference :Theoretical

considerations and an alternative technique .J Prosthet Dent 1999 ;82(2):237-241.

8. **Dae Gyun Choi ,John F. Bowley ,David B.Marx ,and Seung Lee .**Reliability of an ear-bpw arbitrary face-bow transfer instrument .J Prosthet Dent 1999 ;82(2):150-156

9. **Edwin H.Getz, Marshall S.Getz, Edwin S.Getz.** Application of a geometric principle for locating the mandibular hinge axis through the use of a double recording stylus. J Prosthet Dent 1988 ;60(5):553-559

10. **Gabriel R.Zuckerman.** Practical considerations for using the face-bow for complete denture prosthodontics. J Prosthet Dent 1985 ;53(2):219-221

11. **Gustaf Hellsing , Eva Hellsing , Soren Eliasson.** The hinge axis concept: A radiographic study of its relevance. J Prosthet Dent 1995;73(1):60-64

12. **Harry Sicher .**The biologic significance of hinge axis determination .J Prosthet Dent 1956;6(5): 616-620

13. **Hussein S.Zaki, Katalin J.Ketzan, Ivo P.Janecka.** The use of modified ear face-bow in restoration of orbital defects. J Prosthet Dent 1995 ;73(6):553

14. **Jack D. Preston .**A reassessment of the mandibular transverse horizontal axis theory : J Prosthet Dent .2004; 91(6): 505-512 .

15. **John F .Bowley ,Steven M .Morgan .**Occlusal plane discrepancies generated by transverse horizontal axis deviations .J Prosthet Dent 2001;86(1):67-73 .

16. **John Joy Manapallil.** Complete Denture Prosthodontics.First Edition.2004

17. **John K.Schulte , Dennis J.Rooney , Arthur G.Erdman .**The hinge axis transfer procedure :A three –dimensional error analysis .1984;51(2);247-251

18. **Joyce E.Palik, Donald R.Nelson, James T.White.** Accuracy of an earpiece face-bow. J Prosthet Dent 1985 ;53(6):800-804

19. **Lawrence A .Weinburg .**An evaluation of the face-bow mounting .J Prosthet Dent 1961; 11(1):32-42 .

20. **Lawrence A.Weinbeg ,**The transverse hinge axis :Real or imaginary .J Prosthet Dent .1959 ; 9(5):775-787 .

21. **Mahmoud Khamis Abdel Razek .**Clinical evaluation of methods used in the mandibular hinge axis.J Prosthet Dent .1981;46(4):369-373 .

22. **Margaret Yanus ,Israel M .Finger ,Roger Weinburg .**Comparison of a universal mounting jig to a face-bow .J Prosthet Dent .1983;49(5):623-627 .

23. **Olaf Bernhardt ,Nina Kuppers ,Michael Rosin ,Georg Meyer.**Comparitive tests of arbitrary and kinematic transverse horizontal axis recordings of mandibular movements :J Prosthet Dent .2003;89(2):175-179 .

24. **Olle Borgh ,Ulf Posselt ,Dr.odont** :Hinge axis registration:Experiments on the articulator .J Prosthet Dent 1958; 8(1):35-40 .

25. **P .F.Simonet ,J .A.Clayton .** Influence of TMJ dysfunction on Bennett movement as recorded by a modified pantograph .Part II : Pilot articulator study .J Prosthet Dent .1981;46(5):545-549

26. **P .M.Walker .**Discrepancies between arbitrary and true hinge axes .J Prosthet Dent .1980;43(3):279-284 .

27. **Panayiota Hatzi ,Philip Millstein ,Alvaro Maya .**Determining the articulator interchangeability and hinge axis reproducibility .J Prosthet 2001;85(3):236-245 .

28. **R.B.Gunderson, M.H. Parker.** An alternative technique for location of the hinge axis. J Prosthet Dent 1987 ;58(4):448-450

29. **Raymond Cohen .**The hinge axis and its practical application in the determination of centric relation .J Prosthet Dent.1960; 10(2):248-257 .

30. **Robert P .Renner ,Virgil M .S.Lau .**Hinge –axis location and face – bow transfer for edentulous patients .J Prosthet Dent.1976;35(3):352-356

31. **S.Parichereh Shodadai, Jens C .Turp ,Thomas Gerds ,Jorg R.Strub .**Is there a benefit of using an arbitrary face-bow for the fabrication of a stabilization appliance .Int J Prosthodont 2001;14(6):517-522 .

32. **Sheldon Winkler.**Essentials Of Complete Denture Prosthodontics.Second Edition.

33. **T .F .Lundeen,F.Mendoza.**Comparison of Bennett shift measured at the hinge axis and an arbitrary hinge axis position.J Prosthet Dent.1984;51(3):407-410.

34. **Ulf Posselt .**Terminal hinge movement of the mandible .J Prosthet Dent.1956;86(1):787-797.

35. **Vincent R Trapozzano ,John B .Lazzari .**A study of hinge axis determination .j prosthet Dent .1961; 11(5):859-863 .

36. **Virgilio F.Ferrario ,Chiarella Sforza ,Graziano Serrao ,Johannes H.Schmitz .**Three dimensional assessment of the reliability of a postural face-bow transfer .J .Prosthet Dent .2002;87(2):210-215 .

37. **Walter R Teteruck ,Harry C .Lundeen .**The accueacy of an ear face-bow .J Prosthet Dent 1966;16(6):1039-1046 .

38. **William W .Nagy ,Thomas J.Smithy ,Carl G.Wirth .**Accuracy of a predetermined transverse horizontal mandibular axis point .J .Prosthet Dent 2002;87(4):387-394 .

39. **Y.M.Balthazar, G.J.Zeibert, Sara Jean Donegan.** Effect of interocclusal records on transverse axis position. J Prosthet Dent 1984 ;52(6):804-809